especially as amended, recite patentable subject matter and should be allowed. Reconsideration and allowance are therefore respectfully requested.

Prior to contending with the grounds upon which the rejections are founded, a brief summarization of the essentials of the invention "dry process" for providing a uniform and reproducible surface of low-resistance electrical contact between a metal and a layer of polycrystalline p-type CdTe surface of a semiconductor device by an argon beam of Ar atoms prior to forming a contact interface or additional semiconductor layer.

Applicant is the first to invent a "dry process" for making a uniform and reproducible surface of low-resistance electrical contact between a metal and a layer of polycrystalline p-type CdTe surface through the use of a unique form of Ar ion beam processing for a period of about 1 minute to alter the surface stoichiometry from Cd-rich to Te-rich as shown in FIG. 8b prior to forming a contact interface or additional semiconductor layer.

The invention process is accomplished by:

a) placing a CdS/CdTe device into a chamber and evacuating the chamber to create a vacuum;

b) orientating the polycrystalline p-CdTe side of the CdS/CdTe device to face apparatus capable of generating Ar atoms and ions of preferred energy and directionality;

c) introducing Argon and igniting the area of apparatus to

e

generate Ar atoms and ions of preferred energy and directionality in a manner so that during ion exposure, the source-to-substrate distance is maintained such that it is less than the mean-free path or diffusion length of the Ar atoms and ions at the vacuum pressure; and

d) allowing exposure of the polycrystalline p-CdTe side of the layer to the ion beam for a period of about less than about 1 minute to alter the surface stoichiometry from Cd-rich to Te-rich as shown in FIG. 8b prior to forming a contact interface or additional semiconductor layer, as is clearly shown in FIG. 9.

Claims 1-2 and 4 were again rejected as being unpatentable over alleged admitted prior art in combination with Schroen et al. under 35 U.S.C. §103 (a).

Applicant respectfully traverses the rejection and requests reconsideration for the following reasons.

The alleged "admitted prior art" on pages 5 and 6 of applicant's specification only refer to methods of making CdS/CdTe devices. These processes clearly lack 1) teaching a "dry process" for providing a uniform and reproducible surface of low-resistance electrical contact between a metal and a layer of p-type CdTe surface of a semiconductor and do not suggest, teach or disclose 2) exposing the polycrystalline p-type CdTe to Ar ions or atoms prior to forming an additional contact interface or semiconductor layer to reduce contact resistance.

The deficiencies of these alleged "admitted prior art" references are not compensated for by any teachings in the secondary reference of Schroen et al.

Schroen et al. disclose a process for fabrication of a semiconductor ohmic contact structure comprising:

a. exposing a selected portion of a semiconductor body to a glow discharge in the presence of an inert gas;

b. exposing the selected portion to a glow discharge in oxygen or nitrogen, at conditions selected to form an adherent uniform film of nonconductor 10-100 Angstroms thick on the selected portion of the semiconductor body; and

c. forming an adherent film of conductor on the nonconductor film, to complete a contact structure having linear I-V characteristics.

Schroen et al. pertains to the use of crystalline Si, and not a polycrystalline CdTe (which is a II-VI material).

Moreover, since the material on which the process of Schroen et al. has been demonstrated is crystalline Si, this Si forms a stable oxide that is non-reactive with most metals.

Schroen et al. does not expose Ar ions to a CdTe surface to obtain a low ohmic contact resistance and does not disclose that during ion exposure of the Ar that the source-to-substrate distance must be maintained so that it is less than the mean-free path or diffusion length of the Ar ions at the vacuum pressure.

Nevertheless, even in the absence of Schroen et al. teaching these two process conditions, the Examiner persists in contending that these two non-taught processing conditions is obvious (presumably based upon personal knowledge).

Since the two non-taught processing conditions is based upon the personal knowledge of the Examiner, applicant respectfully request, pursuant to 37 C.F.R.§ 1.104(d)(2) that the Examiner support this personal knowledge by an affidavit. Upon receipt of the affidavit from the Examiner, applicant will provide a contradictory or explanatory affidavit (s), either by applicant or another expert in this art area.

Clearly, Schroen et al. disclose the use of a "glow discharge in the presence of an inert gas" specifically to activate the Si surface for subsequent formation of "an adherent uniform film of non conductor".

On the other hand, applicant's invention is directed to use of an ion-beam process to condition a polycrystalline p-CdTe surface prior to deposition of an additional semiconductor layer. Consequently, the invention process is not conditioning the surface to facilitate formation of a non conductor (as in the case of Schroen et al.) - but rather a semiconductor.

The ion dynamics and the plasma chemistry occurring in the surface of the clean crystalline Si, and caused by exposure to a 1-10keV glow discharge of Schroen et al., which is at high-

E

voltage, high-pressure is vastly different from the 0.05-2keV ion-beam exposure (low-voltage, low-pressure) of the $CdCl_2$-treated polycrystalline p-CdTe of the invention process.

The improvement in the interfacial current transport at the polycrystalline p-CdTe interface of the invention is by improved alignment of the valence bands between semiconductors.

By contrast, the improvement in current transport of the different Si/oxide/metal interface of Schroen et al. is by creation of "a semiconductor-insulator interface with suitable electrical properties to create an accumulation in the adjacent semiconductor."

Accordingly, even if the "accumulation layer" of Schroen et al. would improve quantum-mechanical tunneling between a semiconductor and a metal, it nevertheless represents very different physics of interfacial current transport, and the process used to provide optimal "activation" of a Si surface is drastically different than the invention process which is used to prepare the surface of a polycrystalline p-CdTe film.

For these reasons, the combination of Schroen et al. with alleged "admitted prior art" cannot be reconciled for purposes of rendering claims 1-2 and 4 obvious under 35 U.S.C. 103(a).

Withdrawal of the rejection is respectfully requested.

Claim 5 has again been rejected as being unpatentable over alleged "admitted prior art" in combination with Schroen et al.,

E

further in view of Lee et al. under 35 U.S.C. §103 (a).

Applicant respectfully traverses the rejection and requests reconsideration for the following reasons.

The alleged "admitted prior art" and Schroen et al. have already been discussed at length.

The deficiencies in the alleged "admitted prior art" and Schroen et al. are not supplied by any teachings of the Lee et al. reference.

Lee et al. disclose an external plasma gun that provides both ions and electrons for bombarding substrates. There is no reference to or acknowledgement of use of this external plasma gun to condition a polycrystalline p-CdTe surface prior to deposition of an additional semiconductor layer.

In the absence of hindsight after access to applicant's invention, the fact that an exit aperture having a diameter of 3cm is disclosed in Lee et al. would provide no incentive for or reason why one skilled in the art would be led to utilize this external plasma gun with an aperture of 3cm in one of its specific embodiments for use as an ion-beam in combination with Schroen et al. and the alleged "admitted prior art" to condition a polycrystalline p-CdTe surface prior to deposition of an additional semiconductor layer.

Withdrawal of the rejection is respectfully requested.

Claim 6 was rejected as being unpatentable over alleged

"admitted prior art" in combination with Schroen et al., further in view of Ebe et al., under 35 U.S.C. § 103 (a).

Applicant respectfully traverses the rejection and requests reconsideration for the reasons hereinafter explained.

The alleged "admitted prior art" and Schroen et al. have been discussed at length supra.

Ebe et al. disclose a method for manufacturing film carrier type substrates in a vacuum by depositing a metal vapor on a file made of an organic high molecular substance and irradiating accelerated nitrogen gas ions on the film simultaneously with the step of depositing metal vapor.

Ebe et al is non-related to the alleged "admitted prior art" and Schroen et al. for the reason that Ebe et al. teaches providing a carrier type substrate that includes a film of organic high molecular weight substance and a metal formed thereon to affect high density mounting of integrated circuits to obtain super-adhesive characteristics. There would be no incentive for or reason why one skilled in the art of making CdS/CdTe devices by conditioning a polycrystalline p-CdTe surface prior to deposition of an additional semiconductor layer would look to the art of obtaining super adhesion between an organic high molecular weight substance and a metal layer formed there over at an appropriate exposure angle of an ion beam source for making a uniform and reproducible surface of a low-resistance

E

electrical contact between a metal and a layer of polycrystalline p-type CdTe surface.

Accordingly, the combination of alleged "admitted prior art" with Schroen et al. and Ebe et al. is untenable under 35 U.S.C. § 103 (a) for purposes of rejecting claim 6 as presently amended.

Note is made of the indication that the Morita and Wotherspoon references may be pertinent to applicant's disclosure; however, a review of these references indicate that they are even less pertinent than the cited and applied references. Accordingly, no further arguments that should be addressed in this regard.

In view of the foregoing amendments, remarks and arguments, and request for an Examiner affidavit, it is believed that the application is now in condition for allowance, and early notification of the same is earnestly solicited.

Respectfully submitted,

Dated: November 29, 2000.

Paul J. White
Attorney for Applicant
Registration No. 30,436

NATIONAL RENEWABLE ENERGY LABORATORY
1617 Cole Boulevard
Golden, Colorado 80401-3393
TELEPHONE: 303-384-7575
Facsimile: 303-384-7499